VOLUME 1

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SPACE SHUTTLE PROGRAM
SHUTTLE AVIONICS INTEGRATION LABORATORY

SAIL PROJECT PLAN

National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

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Volume 1

SPACE SHUTTLE PROGRAM

SHUTTLE AVIONICS INTEGRATION LABORATORY

SAIL PROJECT PLAN

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"PROJECT SCHEDULES"

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

AVIONIS SYSTEMS ENGINEERING DIVISION

SHUTTLE AVIONICS INTEGRATION LABORATORY

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FOREWORD

Documents which provide a basis for management of the Shuttle Avionics Integration Laboratory (SAIL) have been developed to implement the requirements set forth in the Space Shuttle Level II Program Definition and Requirements Documents and by other applicable governing documentation. SAIL requirements, directives, procedures, et cetera, which are controlled by the SAIL project management are documented within the volumes of JSC-08663.

All NASA and contractor organizations involved in SAIL activities must adhere to the requirements in these baselined volumes. Any deviations from or changes to such requirements must be submitted along with full justification to the SAIL Manager. These management volumes will be maintained current by change pages or revisions as required.

This volume, Volume I of JSC-08663, describes the objectives and approach for the SAIL and presents the management methods, roles and responsibilities applicable to the SAIL. The current volumes of JSC-08663 are as follows:

Volume	Title
1	SAIL Project Plan
2	Configuration Management Plan
3	Documentation Management Plan
4	Data Management Plan
5	Safety, Reliability, and Quality Assurance Management Plan
6	Operations Management Plan
7	Logistics Management Plan
8	Computer Systems and Software Management Plan
9	Interface Control Documents Management Plan
10	Mated Elements Management Plan

Donald G. Wiseman
Assistant Chief for SAIL, ASED
August 5, 1974

CONTENTS

CONTENTS (Continued)

TABLES

FIGURES

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Shuttle Avionics Integration Laboratory (SAIL) has been established at the NASA Johnson Space Center (JSC) to perform avionics system integrated testing in direct support of the Space Shuttle Program. The SAIL provides a central facility where the avionics and related hardware (or simulations of the hardware), flight software, flight procedures, and associated ground support equipment will be fully integrated for testing. The SAIL will be dedicated to the support of the Space Shuttle Program. It will be the ultimate aim of the SAIL to exercise the complete configuration of each Orbiter flight or mission before actual flight. The laboratory will provide a test bed for the verification of all avionics interfaces of other Shuttle Program Elements including:

- o External Tank (ET)
- o Space Shuttle Main Engine (SSME)
- o Solid Rocket Booster (SRB)
- o Launch Processing System (LPS)
- o Payloads

A full set of flight qualifiable Orbiter avionics subsystems hardware and mated elements hardware will be incorporated in the SAIL. This hardware will provide the basic configuration which the systems integration and mission verification testing will be performed.

1.2 PURPOSE OF THE SAIL PROJECT PLAN

The primary purpose of the SAIL Project Plan is to provide a program insight into the specific functions of the SAIL, the organization and interfaces of the SAIL, and the methods to be utilized in management of the SAIL. The objectives of the SAIL are directly program related, hence, the management and organization of the SAIL are conceived in project fashion with emphasis on schedule and cost as well as technical product.

The SAIL Project Plan responds directly to the management and technical requirements contained within the volumes of the Level II Program Definition and Requirements document, JSC-07700: and to appropriate Space Shuttle Program Level volumes of the Master Verification Plan and applicable Shuttle program directives.

The SAIL Project Plan delineates management roles and responsibilities and describes the means of implementing Shuttle Program management policies relative to SAIL.

The secondary purposes of this plan include:

- o Clarification and specific delineation of the Space Shuttle Programmatic SAIL requirements.
- o Establishing a clear basis for intra-center and inter-center coordination and operations.
- o Serve as the focal point for SAIL objectives.
- o Present functional organization interrelationships.
- o Provide single source guidance and direction for SAIL Project and lower level management.

1.3 SAIL OBJECTIVES

The overall objective of SAIL is to serve as a test facility which can demonstrate and verify that all of the various elements of the Shuttle integrated avionics system, along with the various units of non-avionics that interface directly with the avionics, perform successfully according to all applicable specifications when operated simultaneously in all integrated modes of operation. The testing will be conducted, using qualifiable flight hardware and flight software in the multi-string configuration along with directly related ground check-out systems. Subsequent to the primary verification, SAIL will conduct avionics performance evaluations relative to each Shuttle mission. Table 1-1 presents the major objectives of SAIL. Incidental to the accomplishment of the major objectives, a number of secondary objectives will be accomplished. Some of these are:

- o Perform early integration and validation of interfaces between avionics and ground check-out or launch support equipment.
- o Provide test facility for evaluation of mission anomalies and the development and evaluation of "work arounds".
- o Provide a familiarization resource for flight crew and mission operation organizations in the characteristics of the avionics systems.
- o Provide mission operation experience in system check-out and combined ground/vehicle operations.

The SAIL will be implemented and utilized specifically to integrate the various Shuttle avionic sub systems and system elements into a functioning total avionics complex. This complex will then be used to verify the integrated avionics functions. These objectives will be met through a sequence of laboratory test phases. These will include functional open and closed loop tests of the integrated avionics and specifically flight control, integrated communications, and associated data processing. Open loop tests will be initiated by the test operator and results displayed back to the operator, while closed loop test stimuli will be initiated by a computer and will include math

Table I-I Major SAIL Objectives

The major SAIL objectives are to:

(I) Verify the systems function and compatibility of the integrated orbiter avionics and the associated software.

(2) Verify the avionics interfaces, integrated function and avionics mission capability of the orbiter, the mated elements (ET, SRB, and SSME) and the Launch Processing System (LPS).

(3) Verify the avionics interfaces between payloads and the orbiter.

(4) Perform systems level investigations and verifications for:

Mission Unique Software

Mission Functional Requirements

Operational Anomalies

Effects of System Design Changes.

models of the vehicle dynamic responses. Evaluations of the redundancy management functions will also be conducted. The SAIL specifically will not be utilized for Shuttle avionic subsystem and component development or for generalized support to subsystem and component unique evaluation. The SAIL will also not be used as an exclusive flight control mission evaluator although a portion of the SAIL mission support objectives will be met through such testing.

1.4 SAIL DESCRIPTION

A phased incremental approach is planned as SAIL evolves to its full capability. Each subsequent phase builds logically upon the previous phase until a final Mission Operations Support status is achieved. Table 1-2 presents the major activities associated with this phased approach.

1.4.1 MAJOR SAIL OPERATIONAL ELEMENTS

Each major operational element of the basic SAIL configuration is listed here along with a brief description of the function of each. Appropriate modifications to the SAIL will be incorporated as the laboratory evolves under its phased approach in order to meet the SAIL objectives during the specific phase.

1.4.1.1 AVIONICS FLIGHT SYSTEMS (AFS)

During the activation phase (Phase I), a single-string core avionics configuration of the avionics flight system will be installed and integrated into the test area. This configuration will be utilized during laboratory performance evaluations and early systems integration testing.

Subsequent phases of SAIL will be configured with flight qualifiable avionics hardware in a multi-string configuration. This hardware will be installed in a three dimensional mock-up consisting of a cockpit, forward equipment bays, and AFT equipment bays. Wiring harness will be near flight configuration in all respects, i.e., length, size, and routing. A primary goal of SAIL is to include a maximum number of flight avionics components in the open and closed loop testing performed in the SAIL.

During Phase III, the total Shuttle avionics system will be integrated into SAIL. This will include the mated elements, i.e., SSME, SRB, ET, and LPS. Each of these will consist of the following:

SSME - Engine controllers, connector plate, interfacing cabling, and engine simulator to provide inputs to the controllers.

SRB - Electrical power circuitry, data multiplexers, connector plates, interface cabling, rate sensors, TVC interface, pyrotechnics controllers, and SRB system simulators.

Table I-2 Shuttle Avionics Integration Laboratory Phases

PHASE I - ACTIVATION

- o Install Laboratory Test Systems
- o Integrate early Flight Subsystems
- o Accomplish Laboratory Performance Testing

PHASE II - ORBITER AVIONICS VERIFICATION, APPROACH AND LANDING TEST

- o Install and Integrate Flight Avionics System
- o Perform Integrated Avionics System Verification Testing
- o Support Approach and Landing Test Program

PHASE III - ORBITER AVIONICS VERIFICATION, ORBITAL FLIGHT TEST

- o Update Flight Avionics System
- o Install and Integrate Mated Elements Avionics
- o Perform Integrated Avionics System Verification Testing
- o Support Orbital Flight Test Program

PHASE IV - MISSION OPERATIONS SUPPORT

- o Mission Evaluations
- o Mission Anomalies
- o Verify Design Changes

ET - Electrical power circuitry, data multiplexers, connector plates, interface cabling, vent valve controller, ET system simulators.

LPS - Multiplexers, interface electronics, and command simulators.

The detail mated element/SAIL interface requirements are defined in JSC-08663 Volume X Mated Elements Management Plan.

1.4.1.2 INTEGRATED TEST AREA (ITA)

The integrated test area will consist of three dimensional mock-up structure representing the Shuttle Orbiter and facilities to support the avionics flight system and the associated test equipment. The facilities will include electrical power, environmental control and mounting support. The layout of the area will simulate as near as possible the actual size of the flight Orbiter and thereby allow near flight configuration wire harnesses.

1.4.1.3 TEST OPERATIONS CENTER (TOC)

The TOC consists of display and control consoles and hardware configured in function and quantity to provide control of the SAIL integrated support complex including communication and direction of test activities.

1.4.1.4 SHUTTLE DYNAMICS SIMULATOR (SDS)

The Shuttle Dynamics Simulator provides the SAIL with six-degree-of-freedom (6 DOF) dynamic simulation capability. The SDS is planned to have a capability to provide simulated orbiter vehicle characteristics, the AFS simulated environment and certain avionics model simulations.

1.4.1.5 SIMULATORS INTERFACE SUBSYSTEM (SIS)

The simulators interface subsystem will accomplish the interface compatibility function including data acquisition, coordination and routing between the Shuttle Dynamics Simulator (SDS), the Avionics Flight System (AFS), and the Test Operations Center (TOC). SIS requirements include the following:

- Transfer, convert and route closed loop simulation data sets from SDS to AFS.
- Transfer, convert and route intermediate SDS calculations for display and/or recording at TOC.
- Acquire, convert, and transfer Avionics Flight System outputs for the SDS and TOC.
- Perform open loop simulations under TOC or SDS control.

- o Perform pretest calibration/verification of SAIL/AFS interface.

1.4.1.6 TEST INTERFACE SYSTEM (TIS)

The Test Interface System (TIS) provides interface between the Test Operations Center (TOC) and the Simulation Interface Subsystem (SIS) for control, manipulation, and monitoring of simulation data and status. The TIS provides interface between FAC/GSE and the TOC.

The major functional items in the TIS are the Test Interface Control Module (TICM), Ground Support Interface Unit (GSIU), Signal Termination Module (STM), Nav-aids Test Set, CDC 606 recorders and visual and timing support equipment.

1.4.1.7 ELECTRONICS SYSTEM TEST LABORATORY (ESTL)

The Electronic System Test Laboratory (ESTL) contains the communications hardware necessary to support tests to accomplish the SAIL test objectives of verifying experimentally that the Shuttle RF communications links are compatible, identify system performance limitations on operational constraints, establish experimentally the communications channel performance characteristics required for flight operations mission support, and to certify that system parameters are commensurate with mission communications requirements.

1.4.2 SAIL FUNCTIONAL BLOCK DIAGRAMS

Figures 1-1 through 1-4 present functional block diagrams of the SAIL for each phase. The equipment and/or capability added during each phase is indicated by applicable code.

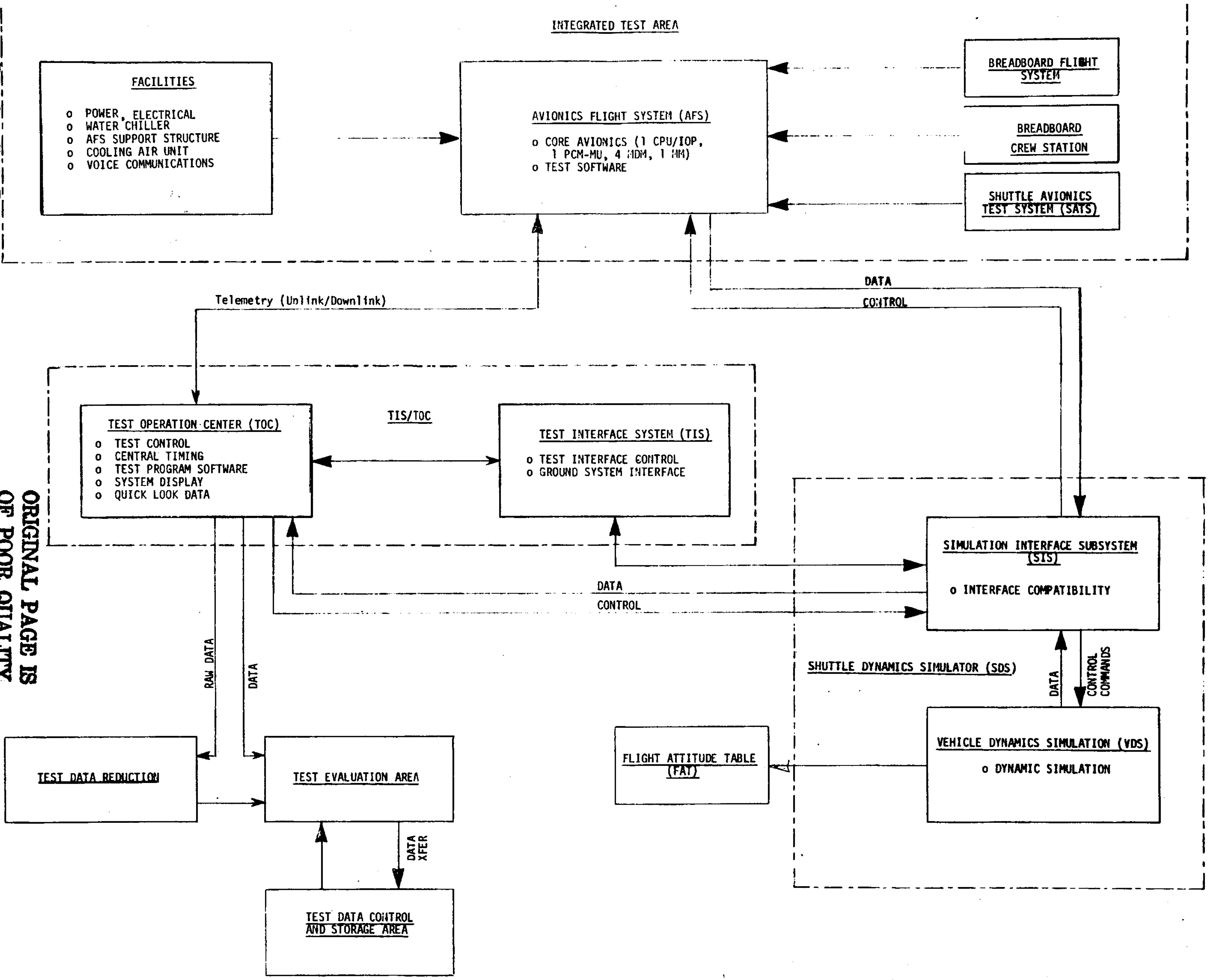

FIGURE 1.1 PHASE I

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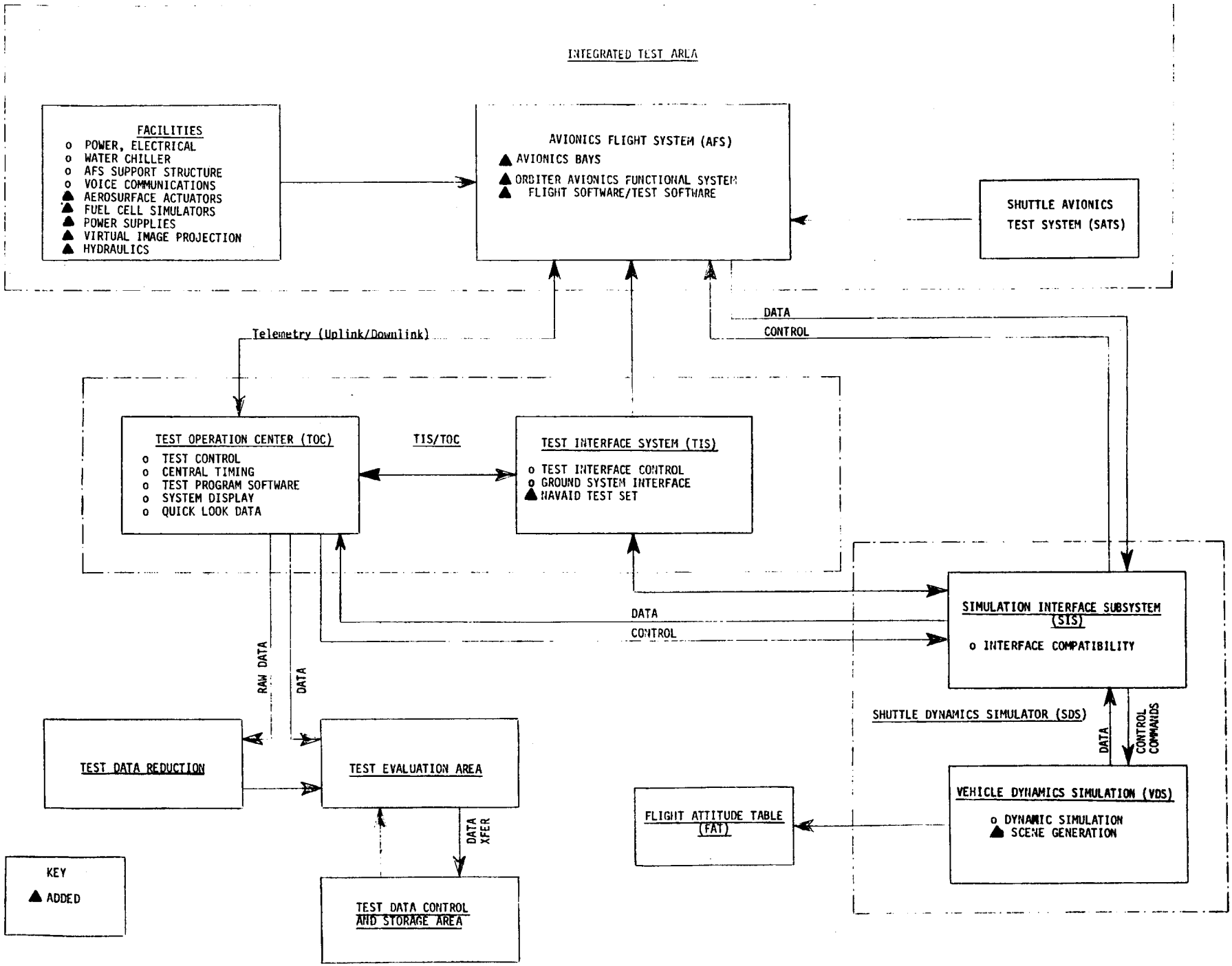

FIGURE 1-2, PHASE II

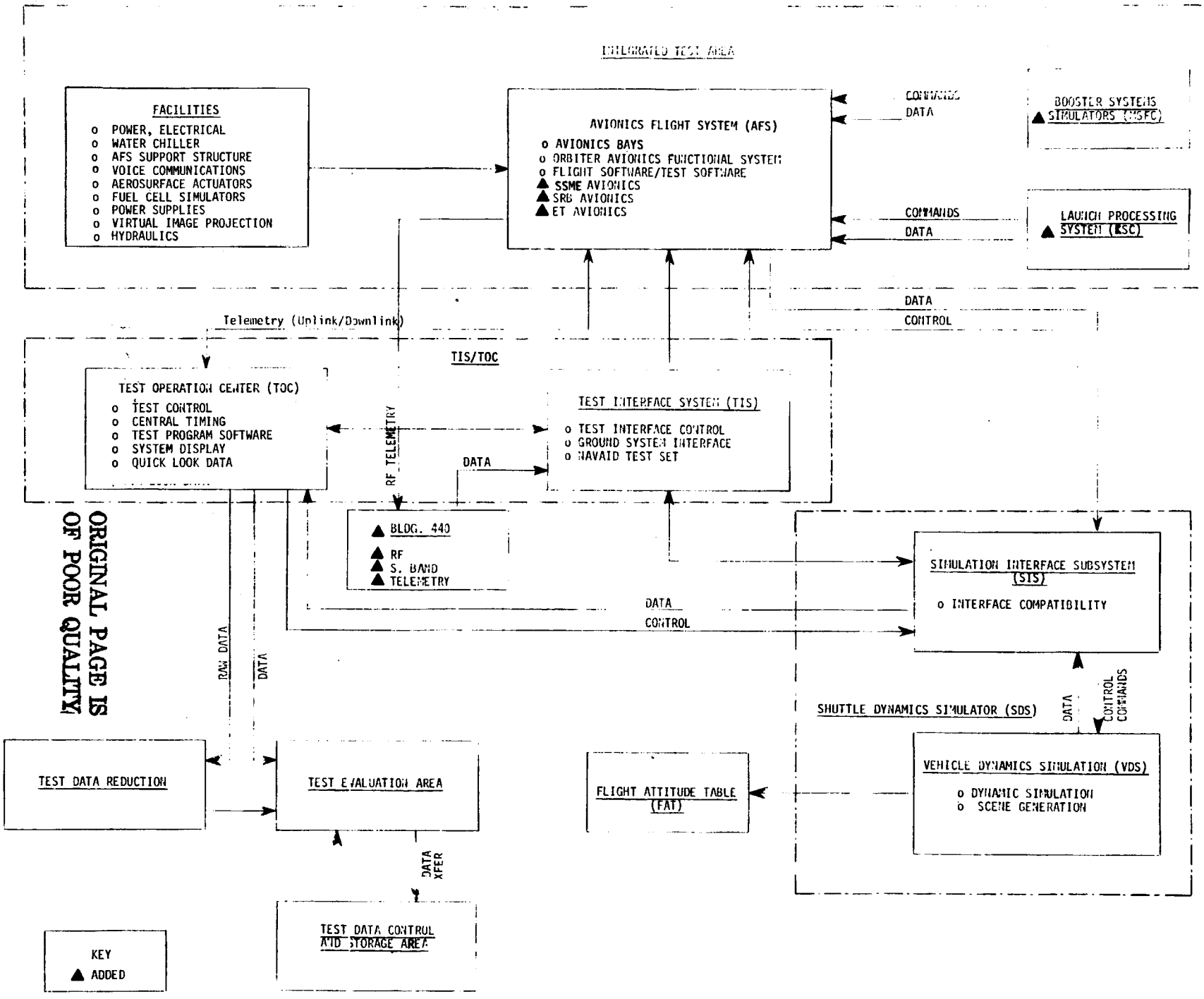

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FIGURE 1-3, PHASE III

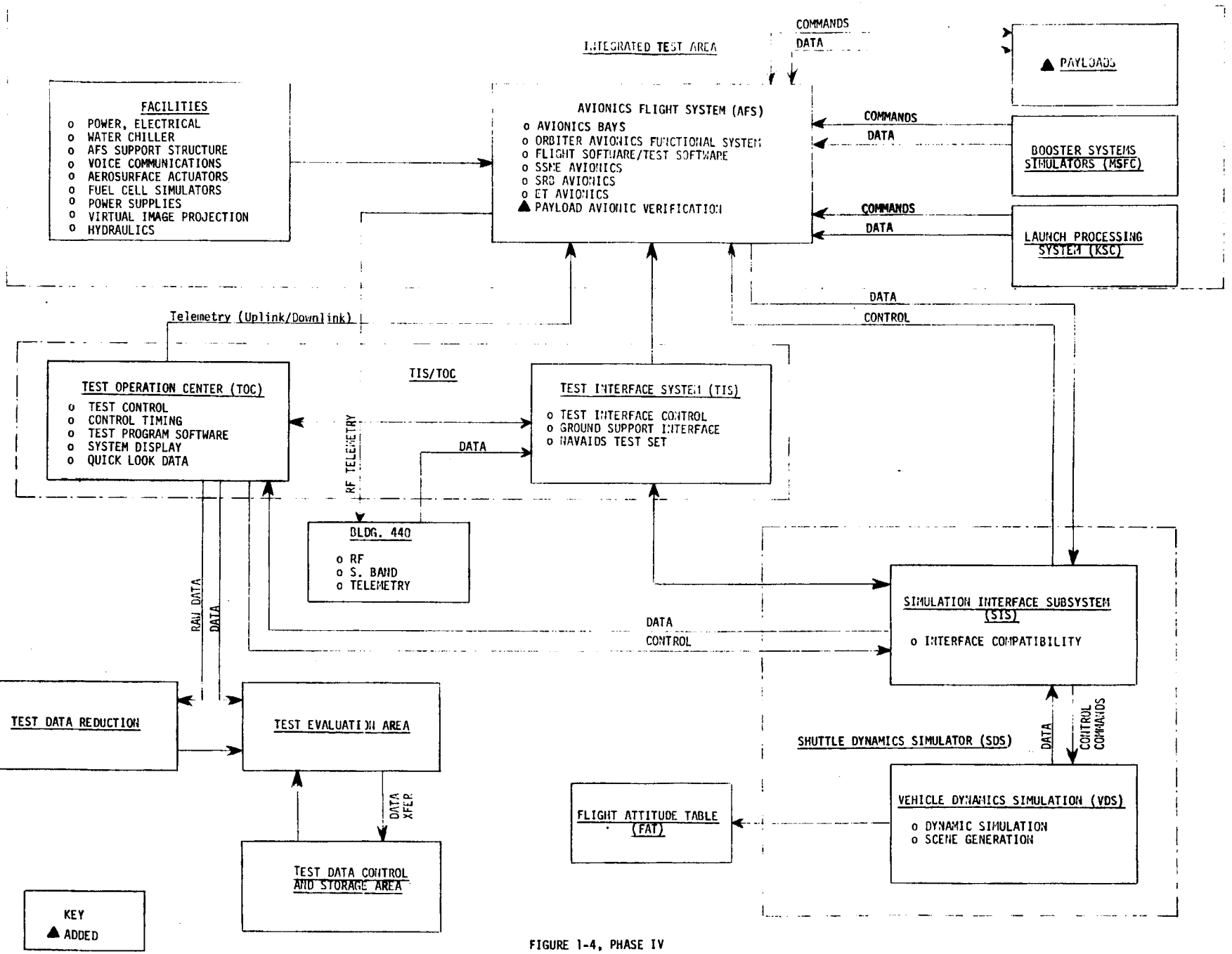

FIGURE 1-4, PHASE IV

2.0 SAIL PROJECT MANAGEMENT

This section presents the management roles and responsibilities for the SAIL project and describes the planned management approach. The SAIL management approach provides visibility and control of the SAIL objectives and activities.

2.1 MANAGEMENT ROLES AND RESPONSIBILITIES

The operation of the Shuttle Avionics Integration Laboratory relies extensively on the support and smooth interfacing of many functional organizations, panels, working groups and contractor organizations. This section presents the detailed project roles and responsibilities of each organization and is described separately

Inter-center and intra-center working agreements or letters of agreement will be prepared in order to clearly identify program requirements, specify activity products and commit to associated schedules and budgets.

Figure 2-1 depicts the primary organizations involved in the planned development and operational use of the SAIL. Detailed organizational responsibilities are included in this section of this SAIL Project Plan.

2.1.1 SPACE SHUTTLE PROGRAM OFFICE/ORBITER PROJECT OFFICE (SSPO/OPO)

The Space Shuttle Program Office (SSPO) and the Orbiter Project Office (OPO) are responsible for the overall management of the SAIL integrated test program. The program and project managers assure provisions for the required detailed planning and documentation during the time the Orbiter Avionics is being manufactured and insure continuity of technical requirements throughout the life of the Avionics. The program and project offices are responsible for overall requirements of the SAIL test program, for specified verification and for general program/project management and have review authority of the general program/project management of SAIL.

2.1.2 ENGINEERING AND DEVELOPMENT DIRECTORATE (E&DD)

The E&D Directorate is responsible for the general implementation of the SAIL and for the test programs conducted therein. The E&D Directorate will provide avionics systems technical support for the check-out, test and data analysis activities as well as the functions described below for the E&DD organizations.

2.1.2.1 SHUTTLE AVIONICS INTEGRATION LABORATORY

The SAIL has been established within the Avionics Systems Engineering Division (ASED) and is organized with a manager, staff and two branches. the staff is responsible for planning and

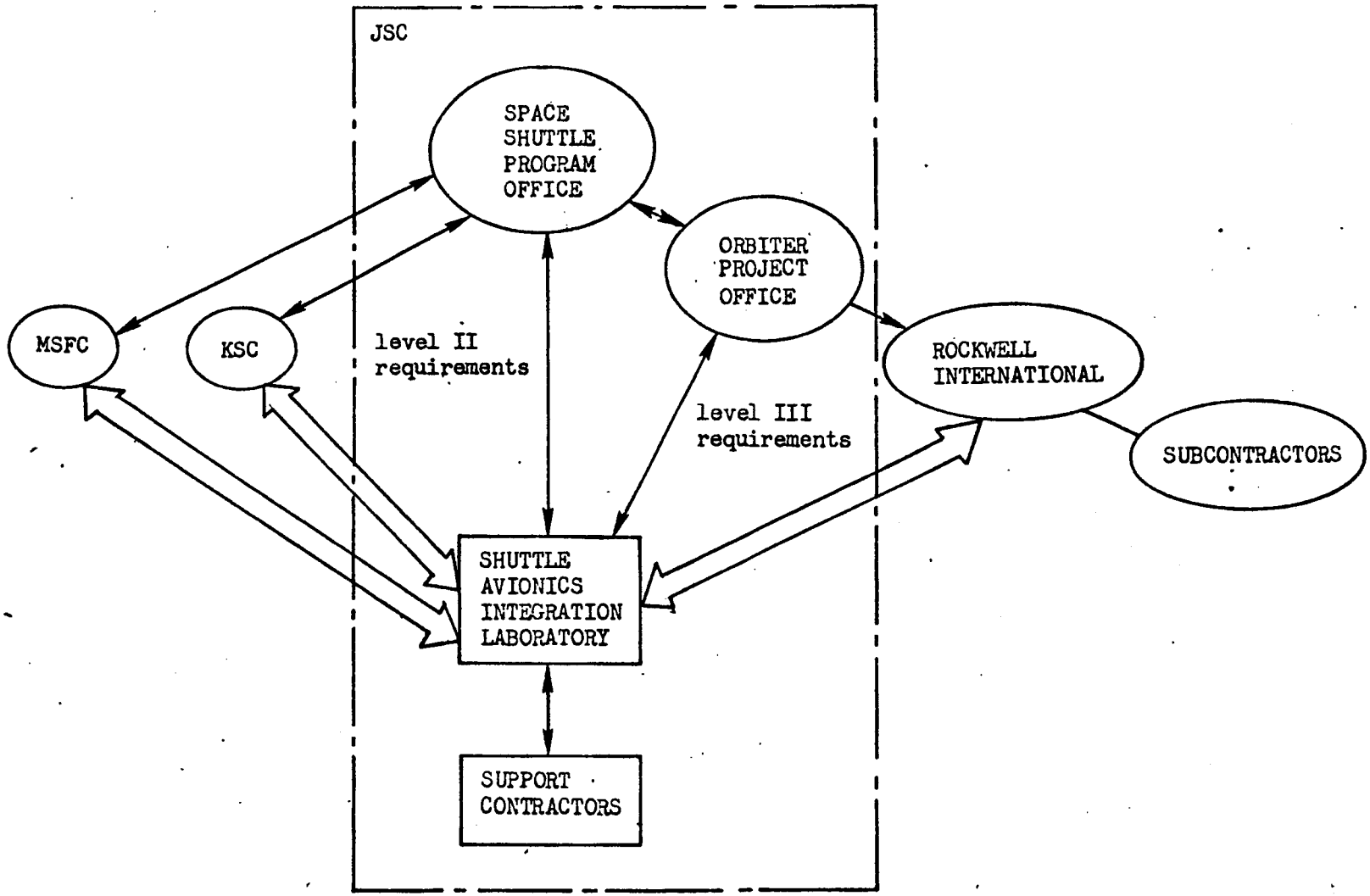

FIGURE 2-1 ORGANIZATIONAL RELATIONSHIPS

technical integration, while the Flight System Test Branch and Check-out System Branch are responsible for management of Avionics Flight System and test laboratory systems, respectively. Contained within the responsibilities are the following:

- Providing centralized SAIL project management of all efforts necessary to establish SAIL and meet program technical and schedule requirements. Establishing project management plans, schedules, budget, technical approach, etc. This includes those SAIL directed efforts of JSC, JSC hardware and support contractors, and SAIL related activities at Marshall Space Flight Center and at Kennedy Space Center. This project management will be performed to meet Shuttle Program requirements within necessary resource and schedule constraints. The SAIL Management Office will provide project status to both program and functional management areas.

- Providing detailed operational direction of the appropriate contractor(s) in the site activation and the preparation, check-out and testing utilizing the SAIL. This responsibility includes Work Breakdown Structure 3.4.8 management of Rockwell International efforts. It also includes detailed technical management of directly assigned efforts of support and hardware contractors to plan, acquire, install, integrate, operate and maintain SAIL systems. This includes direction of the laboratory support contractor, Lockheed Electronics Company and the Space Shuttle Engineering and Operations Support contractor, McDonnell Douglas Technical Services Company.

- Specifically design, implement, operate, and maintain the SAIL facilities except for equipment and functions delegated to other supporting elements. This activity, however, includes responsibility for management of the overall integration of those other delegated SAIL functional elements including acquisition, installation, and operations of avionics flight systems and laboratory systems.

- Establishing necessary integrated test plans and objectives reflecting program and system technical requirements. Planning will include general and detailed scheduling, operational plans and methods, necessary procedures for all operations, and integration and publication of the contractor-prepared test plans and test preparation plans for purposes of assuring integrated SAIL test planning.

- Specifically design, procure, implement, operate, and maintain the Test Operation Center (TOC) to support the SAIL testing program. This is to include hardware and software necessary to interface with the Avionics Flight System and other laboratory support elements, and provide data display and recording as required.

2.1.2.2 SUBSYSTEM MANAGERS

A system has been implemented thru the Shuttle program/orbiter project to provide technical liaison and management utilizing a subsystem work breakdown structure management approach. It is expected that each Work Breakdown Structure (WBS) and/or subsystem manager in conjunction with the Rockwell International counterpart will support acquisition, operation, and performance analysis or the respective hardware in conjunction with the SAIL management office.

2.1.2.3 CONTROL SYSTEMS DEVELOPMENT DIVISION (CSDD)

The CSDD has been made responsible for a number of functions related to SAIL activities. These fall into both hardware, software, and operational simulation areas. It is expected that a large involvement in the SAIL program will be established with CSDD. Specific areas of SAIL support are:

- Shuttle Orbiter Control Subsystems Hardware - As a program support element, the CSDD has been given technical management responsibility for the Rockwell development of the orbiter electrical and electronic systems exclusive of telecommunications. Specifically, the CSDD manages guidance and associated onboard computers, navigation instrumentation, controls and displays, and power distribution. As a function of this technical management, the CSDD will maintain cognizance of the SAIL testing program to assure proper Rockwell engineering attention and SAIL related engineering products. The CSDD will also assure the incorporation of development design changes utilizing the Shuttle configuration management arrangements as requirements for design changes found through the SAIL testing.

- SAIL Simulation Support - The SAIL systems test program involves the integration and operation of simulation systems of the CSDD configured for Shuttle Orbiter. The Hybrid Computation and Simulation Branch will provide the Shuttle Dynamics Simulator (SDS) for the SAIL. Included are a simulation computer, scene generation equipment, a three-axes flight table and simulation interface system development. Simulation computer software and operation of the simulation computer will be the responsibility of the Hybrid Computation and Simulation Branch.

2.1.2.4 TRACKING AND COMMUNICATIONS DEVELOPMENT DIVISION (TCDD)

The TCDD is responsible for Electronics Systems Test Laboratory support for the SAIL.

- The TCDD has been made responsible for technical management of the Shuttle Orbiter communications development. In this capacity, the TCDD will maintain cognizance of the SAIL testing program to assure proper Rockwell engineering attention to SAIL related engineering products. The TCDD will also insure incorporation of development design changes utilizing the Shuttle configuration management arrangements as requirements for design changes identified through SAIL tests.

- TCDD maintains and operates a typical Manned Spaceflight Network ground station in laboratory fashion. It is intended that this ground station be utilized with the SAIL to allow complete interface compatibility to be established. The TCDD will provide laboratory facility and level of effort to meet SAIL test program requirements and to directly participate in test operations.

2.1.3 DATA SYSTEMS AND ANALYSIS DIRECTORATE (DSAD)

The DSAD is responsible for assuring the establishment and implementation of test and flight software requirements for the SAIL/ATA integrated test operations. The DSAD will perform the following functions:

- Develop and maintain flight software for SAIL/ATA integrated test operations in accordance with Shuttle Program/Orbiter Project Office requirements developed for mission support. Develop and maintain SAIL Test Software in accordance with SAIL Project Office requirements.

- Establish and maintain software scheduled deliveries in support of the SAIL Program Master Schedules.

- Provide liaison with the Shuttle prime contractor for development of SAIL software.

- Verify the readiness of software deliverables and certifications thereof to the TRRB.

- Provide support for SAIL test data reduction and processing.

2.1.4 CENTER OPERATIONS DIRECTORATE

The Center Operations Directorate is responsible for implementation of new and modified JSC facilities. In this capacity, the engineering division will provide the following SAIL support:

- Implement SAIL facility requirements in accordance with SAIL development schedules.

- Provide facility operations support as required for SAIL test operations. (power, communications, etc.)

Additional elements of Center Operations are necessary in support to SAIL through both activation and operations phases. Specific support includes:

- o Implementation of primary facility for SAIL.
- o Shipping and receiving logistics.
- o Photographic support.

2.1.5 SAFETY, RELIABILITY AND QUALITY ASSURANCE DIRECTORATE (SR&QA)

The SR&QA is responsible for assuring that the SAIL program conforms to NASA directives related to safety, reliability and quality assurance, control and certification. The SR&QA will perform the following functions:

- o Provide the quality specialist(s) to serve as single point contact for the SR&QA in matters related to control, certification, quality and safety of test operations.
- o Review and approve the test procedures, test rules and deviations therefrom in accordance with the SR&QA Plan for SAIL.
- o Develop, implement and enforce JSC procedures for quality control monitoring of AFS and SAIL preparation and test.
- o Participate in check-out and test operations to assure that adequate quality documentation is maintained.
- o Review test requirements.
- o Verify the readiness of the AFS and facility for integrated test operations.
- o Assure the reporting and disposition of AFS, SAIL, GFE, and related hardware failures.
- o Receive, maintain, and provide archival storage for all "data package" and quality control documentation submitted for the SAIL/AFS test programs.
- o Maintain and/or assure and inspection/quality control program for the SAIL facilities and the support contractor(s), and for the AFS and the prime contractor to assure work performed is in accordance with authorized instructions and standards.
- o Review the AFS Test Evaluation Plan for quality requirements.

2.2 OTHER NASA CENTERS

2.2.1 KENNEDY SPACE CENTER (KSC)

As a portion of responsibilities, the KSC has accepted for the Shuttle program, and plans to provide a partial Launch Processing System (LPS) for preflight verification of Shuttle systems. Part of the SAIL objectives is the integration and systems operation between the flight system and the LPS. In this activity, KSC will be responsible for:

- o Provision of required LPS hardware and software (on-site or remote, to be determined).
- o Maintenance and operation of LPS in support of the SAIL test program.
- o Provision of LPS performance reports subsequent to SAIL tests.
- o Resolution of LPS anomalies as a function of SAIL tests.

Detailed agreements pertinent to SAIL between JSC and KSC will be documented in inter-center working agreements.

2.2.2 MARSHALL SPACE FLIGHT CENTER (MSFC)

The NASA Marshall Space Flight Center will supply hardware, simulators, software ground support equipment, and test support personnel for all operations involving the Shuttle mated elements which are:

- o External Tank (ET)
- o Space Shuttle Main Engine (SSME)
- o Solid Rocket Boosters (SRB)

Detailed agreements pertinent to SAIL between JSC and MSFC will be documented in inter-center working agreements and the Mated Elements Management Plan (Vol X) of JSC-08663.

2.3 CONTRACTORS

2.3.1 ROCKWELL INTERNATIONAL

Rockwell has been made responsible for the provision of Shuttle orbiter hardware and associated flight systems integration. Within this responsibility is the adequate development of hardware elements to meet Shuttle requirements and the performance of an adequate systems evaluation program to validate systems performance prior to flight missions.

Rockwell responsibilities include:

- Provision of avionics component and subsystem hardware - Rockwell is responsible for providing all test article primary hardware, including avionics components, a cockpit, and interconnecting cabling. To adequately establish the flight avionics system, Rockwell must also provide adequate subsystem and system design information.

- Configuration control - Rockwell will maintain a local record of operational system configuration and will update this record with configuration changes as they occur through primary Rockwell design efforts. Rockwell will also maintain current records of the Avionics Flight System configuration and all differences with the primary operational system design.

- Provision of test software requirements for SAIL and subsequent software integration.

- Provision of flight system software - Arrangements for development of operational software have been established utilizing the Software Development Laboratory. The provision of operational software for "on-board" computation, although the primary responsibility of Rockwell, will be joint responsibility in the development phases.

- Integration and installation of avionics test article hardware - Rockwell will be responsible for provision of "on-site" engineering and technical capability to acquire and install avionic flight hardware and to rearrange and modify this hardware as necessary to maintain necessary configuration.

- Test planning - Rockwell is responsible to provide specific avionics flight system testing requirements and to support the development of complete system test plans for the total SAIL program. A contribution to this effort must also be provided by the testing laboratory.

- Test operations - Rockwell will establish a SAIL test operations capability on-site at JSC for the duration of the SAIL test program. Specifically, this capability will provide for and perform the following functions relative to the Avionics Flight Systems (AFS):

- Test scheduling for the AFS checkout and test operations.

- Identify the requirements for GFE supplies and services to support AFS checkout and testing and provide technical support and maintenance for the AFS and Rockwell furnished GSE.

- Install, check out, test, and certify for integrated test the AFS and related Rockwell furnished GSE.

- Test conduction for AFS tests including provision of a senior test conductor and adequate engineering and technical test operations personnel. Test direction and general operations management will be performed by the SAIL Project Office.

- Accomplish test preparation, monitoring, and record keeping under SAIL Project Office directions.

- Test reporting:

  "as-run test procedures"

  quick-look reporting of tests

  final reporting of tests.

o Management - Rockwell will provide a focused and efficient management "on-site" for all SAIL Rockwell efforts. A specific senior manager will be provided as the primary interface for associated NASA SAIL management. This manager will be a primary member of the SAIL management team. This management will also provide planning and status information of all AFS and support activities. It will support the SR&QA provisions of the SR&QA support plan for SAIL with internal quality procedures of Rockwell.

o Math model provisioning - Rockwell will provide math models for all flight systems to be simulated in the laboratory.

2.3.2 NASA LABORATORY SUPPORT CONTRACTOR - LOCKHEED ELECTRONICS CORPORATION

The Lockheed Electronics Corporation, under direction of the Checkout Systems Branch, will support the design, fabriaction, installation, checkout, and operation of the SAIL exclusive of the Avionics Flight System. Specific functions to be performed are:

o Assist the Checkout System Branch in the overall planning for the SAIL. Products of this activity will typically be planning documentation, SAIL concepts definition, design requirements documents, etc.

o Design the laboratory layout and all test article peripheral equipment such as electrical power supply, coolant supply,

flight system interface equipment, portable test equipment, laboratory control room, facility modifications, etc.

- o Assist the Checkout System Branch in the development of laboratory equipment either by local fabrication or procurement.
- o Develop and program all laboratory computer software. (Math models for all flight systems will be supplied by Rockwell.)
- o Activate the laboratory in preparation for test operations.
- o Operate the laboratory during test operations.
- o Provide laboratory test conductor who will control all laboratory operations under the direction of the NASA test director.

2.3.3 THE SPACE SHUTTLE ENGINEERING AND OPERATION SUPPORT CONTRACTOR - MCDONNELL DOUGLAS TECHNICAL SERVICES COMPANY (MDTSCO)

The Space Shuttle Engineering and Operation Support Contractor will support JSC in the integration of the combined SAIL avionics flight systems and laboratory systems to assure proper performance. In this capacity he will be required to interface to some degree with all of the aforementioned organizations in carrying out the following specific tasks:

- o Systems Integration: Support the general integration of SAIL, including test articles and test systems, and specifically:
  - Integration planning support to JSC for defining, implementing, verifying, and controlling the SAIL elements functional interfaces within and external to the SAIL.
  - Systems engineering support to JSC for Integration of SAIL, including analyses and system troubleshooting.
  - Maintenance and publication of appropriate test system parametric information (e.g., power utilization, instrumentation lists, functional status, etc.).
- o Systems Configuration: Establish general configuration identification of SAIL integrated systems, including providing systems interface plans and formats, determining required technical interface documents, supporting the establishment of general software integration plans and maintaining software configuration for SAIL.
- o Systems Management Support: Integrate SAIL schedules, schedules status, and reporting based on Shuttle program requirements, and integrate SAIL configuration management plans and support change control activities.

- Systems Operations Support: Provide test operations integration planning, including plans for recognition of data requirements, and data collection, maintenance, and dissemination; support establishment of general test plans, operations readiness, schedules, etc., and provide compatible plans for recognition and resolution of test problems and anomalies; perform system level SAIL performance analyses based on test operations.

3.0 SAIL PROJECT MANAGEMENT OFFICE

To meet the stated objectives of SAIL within limitations of schedule and resources, definitive planning is a primary requirement for the implementation of efficient project management and control. A key element to the effective management of the SAIL is the concurrence and commitment of each supporting organization. In consideration of the numerous possible management approaches and methods, the following general responsibilities are planned:

a. Laboratory facilities will be under the direct management of the SAIL Project Management Office.

b. Test system engineering will be directly performed by the SAIL support organizations.

c. Test requirements and procedures preparation and test operations will be accomplished under SAIL Project Management Office.

d. Maximum use will be made of existing functional capabilities of JSC. Associated activities will be managed by the functional organization within specific program plans and commitments managed by the SAIL Project Management Office.

3.1 SAIL FUNCTIONAL ORGANIZATION

The general functions of the SAIL Project Management Office are listed in Section 2.1.2.1 of this document.

3.2 SUPPORT PANELS, WORKING GROUPS, AND BOARDS

This section presents descriptions of some representative panels, working groups, and boards which function in support of SAIL. Additional working groups and panels may be formed on an as required basis from time to time. As appropriate herein, responsible chairmen are identified by functional title. The section is concluded with a delineation of the reporting responsibilities.

3.2.1 SAIL MANAGERS MEETING

The SAIL Managers Meeting has been established to provide a medium for exchange of information, reporting status of participating organizations and to identify potential problem areas. The meetings are held weekly, chaired by the SAIL manager. The meeting includes responsible individuals from each of the participating or supporting JSC organizations, and representatives from each contractor organizations working on SAIL.

3.2.2 SAIL INTEGRATION GROUP

The SAIL Integration Group has been established to coordinate and implement SAIL objectives concerning combined element testing. This group will establish necessary activities to identify and incorporate mated element interface equipment in the SAIL test article, to provide for External Tank, Solid Rocket Booster, Space Shuttle Main Engine, and Launch Processing System Avionics integration and verification. Members of the SAIL Integration Group include responsible representatives from the Marshall Space Flight Center Shuttle Mated Elements Project Office, the Kennedy Space Center Shuttle LPS Project Office, SAIL Project, and participating SAIL organizations and contractors.

3.2.3 SAIL COORDINATION MEETING

A meeting has been established to coordinate the Flight Avionics System hardware, software, and associated support requirements, and includes design, installations, and related activities. Meetings are held monthly. Participants are the SAIL Project Office and associated support elements.

3.2.4 INTERFACE CONTROL WORKING GROUP (ICWG)

The purpose of the SAIL ICWG is to identify equipment interfaces and establish the Interface Control Document (ICD) requirements for each interface. There are three types of interface areas in SAIL:

a. Between operational equipments (Orbiter, Mated Elements, LPS)

b. Between GFE support equipments

c. Between Flight System equipment and GFE support equipment

The ICD and ICD verification plan for the Flight System are developed by the Level II and Level III CCB. The SAIL authority is limited to maintaining the integrity of the systems interfaces and implementing changes as directed by the appropriate Level II/III CCBs.

3.2.5 TEST PANELS, TEST BOARDS, AND TEST TEAMS

There will be test panels, test boards, and test teams required to support the SAIL integrated test program and test operations. Figure 3-1 presents an overview of the approach to test operations. The functions and responsibilities will be detailed as appropriate in the Tier III and Tier IV test documentation (refer to section 3.3.1).

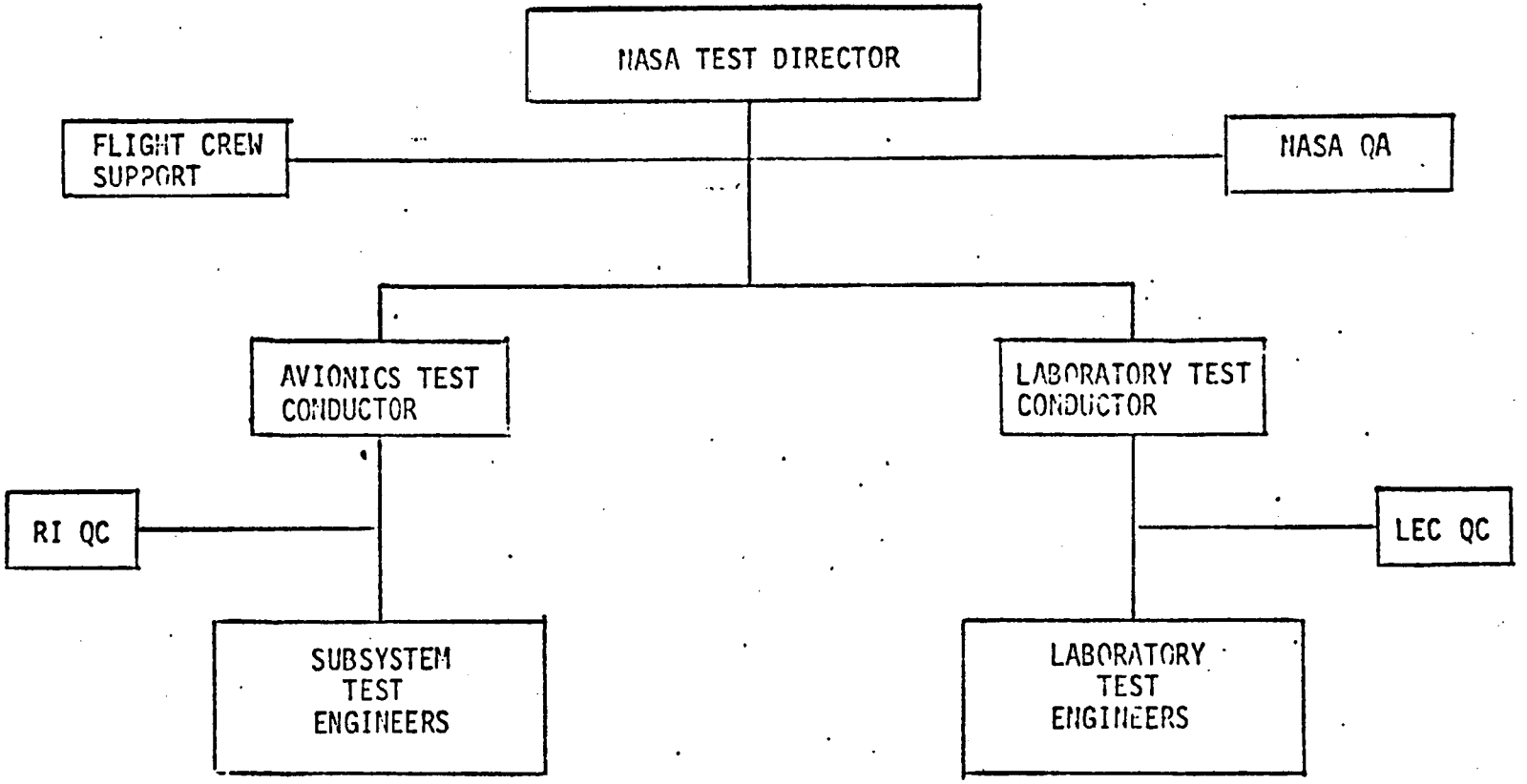

Figure 3-1 Test Operation

3.2.6 REPORTING BY PANELS AND WORKING GROUPS

Each panel and working group chairman will be responsible for the preparation of written minutes. Each chairman will establish the appropriate distribution for minutes.

3.3 SAIL PROJECT MANAGEMENT VISIBILITY

The SAIL Project Manager has the management methods and/or tools described in this section at his disposal in order to maintain visibility and control in the management of SAIL. Each of these contributes to the overall SAIL management approach.

3.3.1 SAIL CONTROLLED MANAGEMENT DOCUMENTATION

The SAIL Project Plan, Volume I of JSC-08663, is the basic planning document for the SAIL project. This document summarizes the SAIL objectives, presents the management roles and responsibilities, and describes the SAIL project management methodology. To augment the SAIL Project Plan, specialized management plans are being prepared by the SAIL Management Office defining approach, procedures and policies to meet Space Shuttle program requirements. Figure 3-2 presents the relationship of the currently planned SAIL documents, and a brief description of each of these documents follows. As deemed necessary, these Tier II management documents may be supplemented with additional volumes (Tier III) and will be defined in the Documentation Management Plan Volume of JSC-08663.

3.3.1.1 Configuration Management Plan (Volume 2 JSC-08663)

- Identifies and defines the policies, management organization, and methodology to implement configuration management of SAIL hardware, software, and documentation.
- Establishes and defines key management elements related to management control of SAIL.

  CCP - Configuration Control Panel
  ICWG - Interface Control Working Group
  TWG - Test Working Group (Test Planning)

- Describes the processes, procedures, and methods for processing changes (hardware, software, documents) and establishing status/accounting methods for SAIL.

3.3.1.2 Documentation Management Plan (Volume 3 JSC-08663)

- Defines the organization, disciplines, and methodology for managing and controlling SAIL documentation including:

  - Documentation Management and Control
  - Documentation Change Control

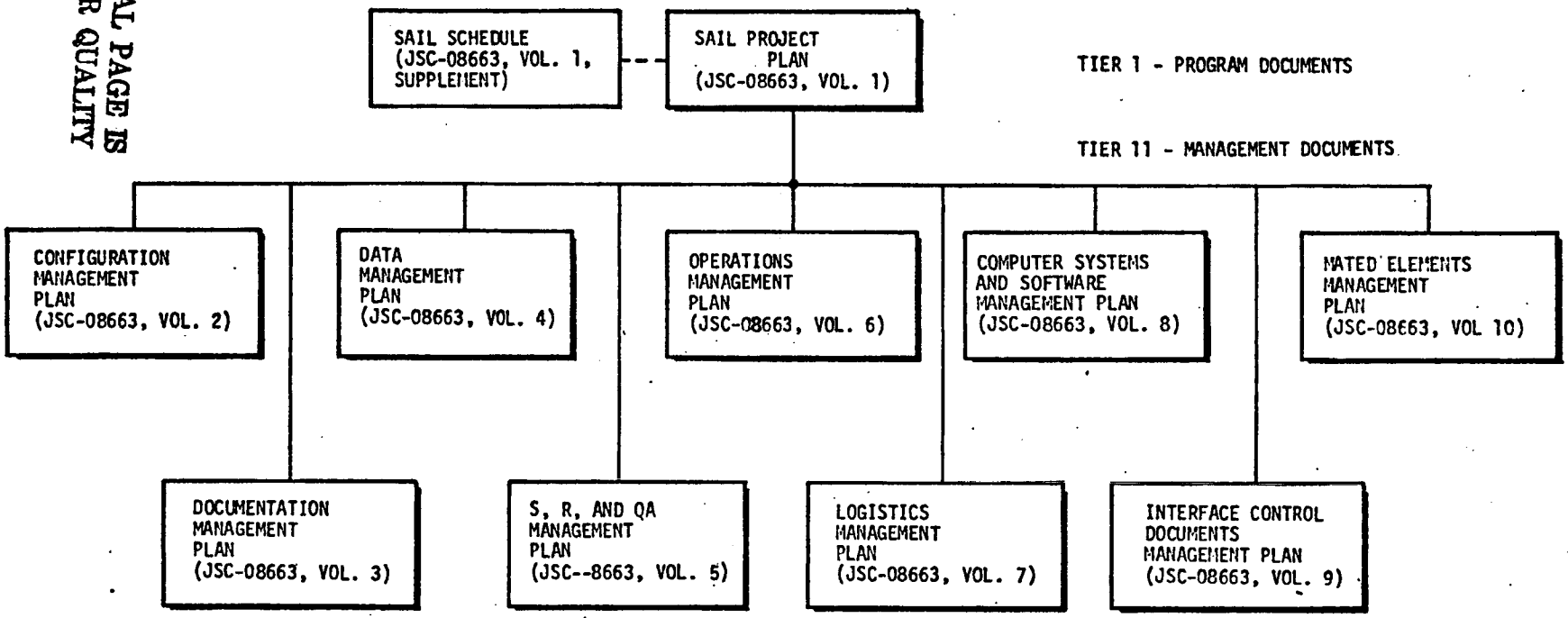

Figure 3-2. - SAIL documentation tree

- o Presents the SAIL Documentation Tree and Index.

- o Describes the processes, procedures, and methodology for preparing SAIL documents.

3.3.1.3 Data Management Plan (Volume 4 JSC-08663)

- o Defines the data requirements for SAIL, identifies organizational responsibilities and interfaces, and provides guidelines for data development.

3.3.1.4 Safety, Reliability, and Quality Assurance Management Plan (Volume 5 JSC-08663)

- o Defines safety, realiability, and quality assurance Requirements for SAIL.

- o Identifies organizational requirements and provides guidelines and procedures for implementing these requirements.

3.3.1.5 Operations Management Plan (Volume 6 JSC-08663)

- o Defines major SAIL operational requirements, identifies organization responsible for these requirements, and provides general guidelines and procedures for implementing these operational requirements.

3.3.1.6 Logistics Management Plan (Volume 7 JSC-08663)

- o Defines the logistics requirements for SAIL, identifies the organizational responsibilities, and provides guidelines and procedures for implementing logistics requirements.

3.3.1.7 Computer Systems and Software Management Plan (Volume 8 JSC-08663)

- o Relates Shuttle Program and Orbiter Project plans and requirements for computer systems and software to the Shuttle Avionics Integration Laboratory (SAIL).

- o Delineates the roles and responsibilities of the organizations involved in developing SAIL related computer systems and software.

- o Defines the computer systems interrelationships for those systems which affect SAIL and identifies the system elements.

- o Defines the reviews, review processes, documentation requirements, configuration management, acceptance procedures, and data control methods which will provide management visibility for progress of the computer systems and software development.

3.3.1.8 Interface Control Documents Management Plan (Volume 9 JSC-08663)

- o Establishes methods for identifying, describing, documenting, and controlling the configuration of SAIL equipment internal interfaces.
- o Defines the organizations and documents required to manage and control SAIL internal interfaces.
- o Describes detailed procedures for use of Interface Control Documents (ICD's) and Interface Revision Notices (IRN's).

3.3.1.9 Mated Elements Management Plan (Volume 10 JSC-08663)

- o Establishes objectives and requirements for mated elements (i.e., ET, SSME, SRB, LPS, and Payloads).
- o Delineates roles and responsibilities of organizations involved in development of SAIL interfaces.
- o Defines documentation requirements associated with SAIL/mated elements.
- o Relates operation requirements to mated element testing.
- o Defines test configurations to be utilized in SAIL.

3.3.2 SAIL MASTER SCHEDULE

The SAIL Master Schedule will be published as a supplement to this SAIL Project Plan and form a part of the document. This schedule will define the major milestones of SAIL and relate them to Shuttle program milestones.

3.3.3 SAIL CONFIGURATION CONTROL PANEL

The CCP is the principal management tool responsible for the control of SAIL operation.

The Configuration Control Panel (Level IV CCP) is established as the primary functional element to define, integrate, and implement the configuration management policies, requirements, and procedures for SAIL.

The CCP will be chaired by the SAIL Project Manager. The membership of the panel will include representatives from the Shuttle Program Office, Orbiter Project Office, Safety, Reliability, and Quality Assurance Directorate, and key members of each SAIL system functional elements.

The primary SAIL system functional elements include:

- o Orbiter
- o Mated Elements
- o Launch Processing System
- o SAIL Test Systems (i.e., Test Operations Center, Shuttle Dynamics Simulator, etc.). Sub panels of the CCP are organized under the supporting elements for changes not affecting interfaces.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

ACE	Automatic Checkout Equipment
AFS	Avionics Flight System
ALT	Approach and Landing Test
ASED	Avionics Systems Engineering Division
CCP	Configuration Control Panel
CMO	Configuration Management Office
CSDD	Control Systems Development Division
DPS	Data Processing System
DSAD	Data Systems and Analysis Directorate
E&DD	Engineering and Development Directorate
ESTL	Electronics Systems Test Laboratory
ET	External Tank
FAT	Flight Attitude Table
FOD	Flight Operations Directorate
GFE	Government Furnished Equipment
GSE	Ground Support Equipment
IBM	International Business Machines Corporation
ICWG	Interface Control Working Group
IMU	Inertial Measurement Unit
ITA	Integrated Test Area
JSC	Johnson Space Center
KSC	Kennedy Space Center
LEC	Lockheed Electronics Corporation
LPS	Launch Processing System
MCC	Mission Control Center

ACRONYMS AND ABBREVIATIONS (Continued)

MDTSCO	McDonnell Douglas Technical Services Company
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
OFT	Orbital Flight Test
OPO	Orbiter Project Office
QA	Quality Assurance
QC	Quality Control
RF	Radio Frequency
RI	Rockwell International Corporation
SAIL	Shuttle Avionics Integration Laboratory
SATS	Shuttle Avionics Test System
SCCPD	SAIL Configuration Control Panel Directive
SDL	Software Development Laboratory
SDS	Shuttle Dynamics Simulator
SIS	Simulator Interface Subsystem
SR&QA	Safety, Reliability and Quality Assurance
SSME	Space Shuttle Main Engine
SSPO	Space Shuttle Program Office
SVCS	Services
TBD	To Be Determined
TIS	Test Interface System
TOC	Test Operations Center
TRRB	Test Readiness Review Board
TWG	Test Working Group

ACRONYMS AND ABBREVIATIONS (Continued)

UTE	Unified Test Equipment
WBS	Work Breakdown Structure
XFR	Transfer
6 DOF	Six-degree-of-freedom